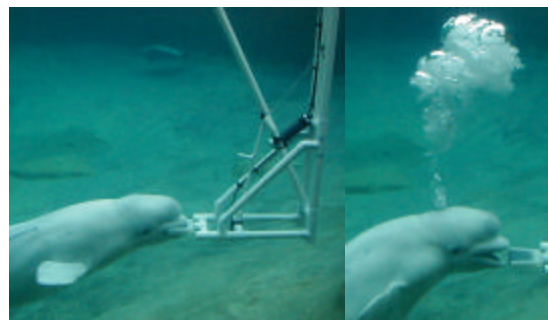


Hearing Tests for Marine Mammals

The Office of Naval Research, in partnership with NOAA Fisheries, is sponsoring a project to study the hearing ability of two white whales at Point Defiance Zoo and Aquarium (PDZA) in Tacoma, Washington, through a collaborative effort with the U.S. Navy Marine Mammal Program in San Diego. Marine mammals use hearing for communication and navigation in the ocean and their hearing is highly developed, but we know little about how loud different sounds seem to them.

Scientists determine how well marine mammals hear by teaching them to respond to a sound. The response can be hitting a paddle or vocalizing with a grunt or whistle. The lowest sound level that an animal can detect, the hearing threshold, is found by reducing the level of the sound until the animal does not respond, indicating that he no longer hears it. An audiogram is a graph of hearing thresholds versus frequency. Frequency is the number of oscillations per second (called Hertz and abbreviated Hz) contained in the sound; an example of a low-frequency sound is the growl of a bear and an example of a high-frequency sound is a coach's whistle.

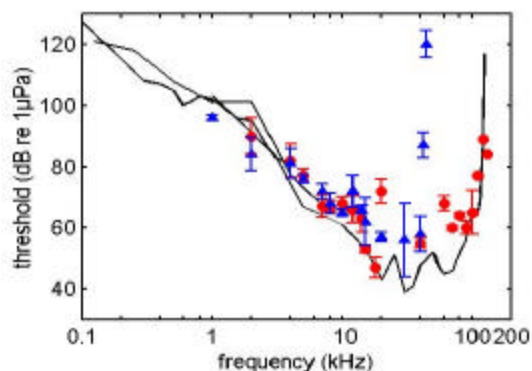


White whale at test station for hearing test (left). White whale whistles in response to sound (right).

Although we can measure sound levels underwater, we do not know how loud a sound will be to a marine mammal because in addition to sound level, loudness depends on frequency and sound quality. Loudness depends on frequency because hearing sensitivity changes with frequency. Sound quality is more subjective; it relates to the meaning sound has to us. For example, fingernails screeching across a blackboard will sound much louder to us than relaxing music playing on our favorite radio station even though they have the same measured sound level.

In traditional human loudness tests, individuals rate the loudness of a tone on a scale of 1 to 10. These tests are impossible with marine mammals, however, because they cannot communicate to us what they think; but, loudness of a sound may be approximated in these animals by measuring their response or reaction times in a hearing test. In this case, the reaction time is the interval between onset of the test tone and the whale's whistle. Animals will respond more quickly to a sound as it becomes louder to them.

Scientists from San Diego tested the hearing of the two white whales at the PDZA and found that one had high-frequency hearing loss (the cause of this loss is unknown, but marine mammals, especially males, like humans, tend to lose high-frequency hearing with age). They are now measuring their reaction times to different tones. The reaction times will be used to estimate the loudness of sounds to these animals at various frequencies and sound levels. Estimates of loudness for these particular white whales — one with normal hearing, the other with high-frequency hearing loss — will provide important information on how hearing loss affects auditory capability and the perception of loudness in these animals.



Hearing thresholds displayed in an audiogram for two white whales: the whale with thresholds indicated by blue triangles has high-frequency hearing loss.